State Decisions Affecting Nuclear Power in the Restructuring Process

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In moving to a more competitive electricity market, regulators and legislators in many states must decide how to handle specific issues affecting nuclear power plants. Although many nuclear questions fall under federal authority, economic and ratemaking issues fall under state authority or involve joint state-federal responsibilities. This paper explores the primary issues and the policy options available for dealing with them, including the pros and cons of those options. The primary questions include (1) whether power from nuclear plants should be required to compete immediately based on incremental costs; and (2) whether and how to assure that decommissioning and other safety-related costs are collected under a more market driven system. The paper also examines how states may influence some areas of federal responsibility such as nuclear fuel disposal. To set the context for later discussions, there is a review of the present status of nuclear power in the United States.

Where Is the Nuclear Industry Now?

Competition improves performance

The performance of U.S. nuclear power plants has improved since the late 1980s. Capacity factors are rising. The median three-year average capacity factor for 1993-95 was 79 percent, 12 percentage points above 1986-88.[1] The bottom quartile in 1993-95 (70 percent capacity factor) is better than median performance in 1987-89. The average capacity factor in 1996 exceeds 80 percent. Both the forced outage rate and the average duration of refueling outages have been declining.

Operation and maintenance (O&M) costs are declining. Non-fuel nuclear O&M costs have fallen 10 percent in real terms in dollars per kilowatt (kW) and 17.5 percent in cents per kilowatt-hour (kWh) since 1992.

Many analysts have attributed this improved level of performance to competition. In this view, better performance is needed to maintain economic viability relative to alternatives in an environment of low fossil fuel prices and low costs of constructing new generating plants. Other analysts suggest that a trend is starting to emerge where cutting operations and maintenance (O&M) costs can lead to poor maintenance practices and increased future outages.[2]

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Costs are still high for many plants

Although performance is improving, costs of many plants are still high compared to alternatives. Even General Electric states that 50 percent of existing nuclear plants are currently not competitive.[3] It is necessary to analyze not only O&M costs but also administrative and general (A&G) costs (including employee benefits) and capital additions. Many, if not most, nuclear plants have incremental costs of O&M, A&G, and capital additions above 3 cents per kWh—even assuming relatively high capacity factors and only routine capital spending. These costs exceed expected market prices in much of the country.[4]

Nuclear Plant Performance

Even though overall performance is improving, some nuclear units are not performing well. The capacity factor is likely to vary by type and age of unit. [5]

- Westinghouse units under 600 MW, built in the late 1960s and early 1970s, previously had higher capacity factors than average but are showing more aging than units between 600 MW to 1,000 MW. Their performance, which exceeded the industry average for many years, is now average or slightly worse.
- Large Westinghouse units, particularly those with salt-water cooling, generally have lower capacity factors than the industry average.
- After the Three Mile Island accident, Babcock and Wilcox units had lower capacity factors than average, but their capacity factors rose in the 1990s.
- The capacity factor of large units (over 1,000 MW) is declining more rapidly with age than mid-sized units (600 MW to 1,000 MW). The difference in capacity factor by age 25 could reach 15 to 20 points.

Non-fuel O&M costs in dollars per kW are significantly higher for smaller units and single-unit plants than for larger and multiple-unit plants.[6] Boiling water reactors (BWRs) and Babcock and Wilcox plants also are each about 10 percent more expensive than average, after controlling for other factors.

When a nuclear plant experiences years with lower capacity factor operation, it often also experiences higher O&M costs. This is expected. Units with very low capacity factors incur extra costs to try to raise performance. Nevertheless, economic pressure is increased, since units with lower output at any given time also have higher operating costs.

Units that do not perform well are becoming candidates for closure. General Public Utilities' Oyster Creek unit will be either sold or closed because its O&M costs and capital additions have been very high, even though its recent capacity factor is near the median.[7] Commonwealth Edison will not spend $400 million to replace steam generators at Zion 1 and 2, hastening that plant's closure.[8]

Competition, cost-cutting and safety

There are two thoughts about the effect of cost-cutting on safety. Many analysts say the cheapest performers now are also generally the safest. They point to improved safety as costs

have been reduced (less frequent "scram" conditions requiring rapid shutdowns, higher performance ratings for utilities with lower costs, lower exposure to radiation and worker accidents).[9] Other analysts state that in some cases, focusing on cost reduction can harm worker morale and safety.[10] These conflicting views can be synthesized to claim that maintaining safety while reducing costs depends on the corporate culture of the utility, so that Nuclear Regulatory Commission (NRC) vigilance on safety issues remains necessary.

Current Trends as Restructuring Proceeds

The survival of the fittest is the watchword. Poor performers are likely to close. Some units will shut down if they face large capital outlays like new steam generators, which cost more than $100 million and require outages of several months. Other units, facing large capital investments before restructuring, may remain open even if they are not economically viable if an optimistic management spends money on them.[11] These uneconomic costs are likely to add to the stranded cost burden unless regulators disallow them.

There will be continued cost pressures, as long as fossil fuel costs remain low. This will continue the trend of falling costs and rising capacity factors to some degree. However, the extent to which capacity factors can rise is more limited than in the past. Plants can be refueled more rapidly, but they do require refueling. Nuclear fuel costs are a small portion of total costs. However, they have doubled since the early 1990s, presaging future cost increases when fuel purchased in the mid-1990s enters reactor cores.[12]

The extent to which plant capacity factors can rise is more limited than in the past.

The nuclear industry is likely to consolidate to cut costs. Many utilities that own only one nuclear plant will contract operation to specialists.[13] Some plants may be sold to nuclear specialist companies.[14] Joint purchasing of materials and supplies is becoming common, and some utilities are even banding together to operate plants jointly to improve economies of scale.[15]

Units that perform well can request license extensions. Some utilities have identified the lack of clear waste disposal options as a reason not to file for license extensions.[16] Other observers suggest that costs and regulatory risks involved in seeking a license extension may deter such action.

Finally, the consensus is that no new nuclear plants will be built in the future without major shifts in both fuel prices and public attitudes toward nuclear power. The competitive market rewards short-term profitability and discourages capital-intensive resources, including energy efficiency, renewables and nuclear power.

Restructuring Paradigm

For purposes of this report, a very general restructuring paradigm is used. This report is not debating the specifics of restructuring plans except as they affect nuclear units. Assumed components of electric industry restructuring are:

- Separate generation from other utility services. Require generation, as a general rule, to recover future costs from market price.
- Allow recovery of some part of stranded costs, as defined by state regulators.
- Allow some form of customer choice.

Stranded Cost Recovery for Nuclear Plant Capital Costs

Stranded cost recovery for uneconomic capital costs is squarely within the purview of state regulators and legislators. It has a significant fiscal impact on the current owners of nuclear power plants.[17] However, it is unlikely to have a significant effect on the future operation of nuclear power plants.

Plant owners' financial health and ratepayers' burdens depend heavily on the treatment of stranded costs for capital cost recovery.

The financial health of plant owners and the burden placed on their ratepayers depends heavily on the treatment of stranded costs for capital cost recovery. However, the decision to continue to operate nuclear plants will be based on their future costs, not past sunk costs. If units are cheap, they will run. If units are expensive, they will close. Stranded cost recovery for past capital costs is likely to have little effect on this decision.

Two other important points are related to stranded cost recovery:

- Capital cost recovery does not have the public health and safety implications of plant shutdown O&M or decommissioning costs.
- Including fuel and other inventories in stranded costs may have market implications if a plant continues to operate, as discussed below.

Decommissioning Costs and O&M Costs of Closed Plants

Rationale for recovery outside market prices

There are two arguments why decommissioning and shutdown O&M costs[18] should be recovered from a separate charge paid by everyone instead of from the market price paid for nuclear power.

- These costs are related to protecting public health and safety. The NRC is very concerned about recovery of decommissioning and O&M safety costs.[19]
- These costs were incurred largely because of the past consumption of nuclear electricity and generally are not related to future consumption. The bulk of the costs arose the moment the plant became radioactive for the first time.

Rationale for recovery only through market prices

Two arguments oppose special recovery of these costs from all customers.

- Other power producers must pay their own costs to decommission generation and recover those costs from the market. Nuclear power should not be given a competitive advantage.

- Shareholders may benefit from running a plant as an unregulated asset for several years before it closes. It would therefore be unreasonable to place all the costs of closure on ratepayers.

Policy options
Regulators can choose whether ratepayers pay these costs or not. Regulators could make different decisions for decommissioning costs and shutdown O&M.

Decommissioning costs also could be accelerated to provide greater assurance of collecting money if a premature shutdown occurs. This also reduces shareholder risks. An argument against acceleration is that if ratepayers stop paying the estimated costs after they are recovered, it may become difficult to collect additional charges in the future if estimated decommissioning costs increase.

Shutdown O&M costs can be prorated between ratepayers and shareholders if there is a period of unregulated operation before closure, as in the California nuclear settlements. This concept requires shareholders to pay for part of shutdown O&M if they gain from the unregulated operation of the plant.

Guaranteed Markets and Price Supports for Nuclear Power during the Transition

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The California nuclear settlement provides an example of guaranteed markets and price supports for nuclear power during the transition to a more market driven electricity system. California provided nuclear power with above-market prices for a transition period. The utilities requested payments of $2 billion to $2.5 billion above the expected market price.[20] After 2001-2003, the power would be priced at market. Some view these types of market guarantees as promising for keeping nuclear units operating.

Rationales for guaranteed purchases and price supports
The following rationales have been offered for allowing utilities to charge ratepayers prices above the market price for nuclear plant going-forward costs.

- It is easier to maintain safety and reliability and to ensure that plants are not closed prematurely without economic justification through an orderly transition to competition for nuclear units rather than making them face competitive prices immediately.[21]
- Market prices are low now because of surplus power. However, the cost of running existing nuclear plants is likely to be cheaper than building new fossil plants in the future if prices rise. Therefore, nuclear plants need to be given a price support now, so they will be available when and if prices rise.
- Nuclear plants provide benefits to society by reducing air emissions, including greenhouse gases like carbon dioxide, and by providing fuel diversity for systems otherwise largely dependent on gas and coal. [22]

Rationales for market pricing without guarantees or support

Opponents of a guaranteed price for nuclear power generally support markets working without subsidy. Arguments are made that price supports affect the balance between ratepayers and shareholders and single out nuclear power for favorable treatment.

- The market will set appropriate prices.
- Operating subsidies to any large source of generation may reduce prices in the short term, but they distort the market, reduce competition, keep uneconomic plants open and, possibly, increase stranded costs.
- Price guarantees may upset the balance between ratepayers and shareholders by letting shareholders speculate on future market prices. If nuclear plants receive price supports in the early years, ratepayers may pay extra; but, if market prices rise later, shareholders gain from the higher prices.
- If uneconomic nuclear plants are closed, the competitive market will replace them. At worst, the issue is timing, not long-term resource adequacy.
- Other resources that reduce pollution and improve fuel diversity, such as energy efficiency, are being reduced in the restructuring process. Therefore, these attributes of nuclear power are not a reason to subsidize it.

Policy options

Regulators must choose between phasing nuclear plants into the competitive market over time or requiring them to immediately recover all future costs from the market.

Regulators must choose between two policy directions. One direction would phase nuclear units into the competitive market over time with higher than market prices in the interim. The second direction would simply require nuclear units immediately to recover all future costs (excluding sunk costs of past capital and, possibly, decommissioning or shutdown O&M costs) from the market. If the option of guaranteed purchases and price supports is chosen, regulators must address several implementation issues.

- *Should those prices reflect only costs or give utilities a profit as they reduce costs?* California nuclear price supports are designed in both ways. The mechanisms for San Onofre and Diablo Canyon fix prices for a period of time. If the utility cuts costs or increases the capacity factor, its profits increase. For Palo Verde, partially owned but not operated by Southern California Edison (SCE), the utility recovers its actual costs with no profit, subject to review if costs are 25 percent above initial projections or if the capacity factor is below 55 percent.

- *What is the phase-in period?* Regulators must determine the length of the guaranteed price period. The California public utility commission (PUC) gave San Onofre eight years of price supports. California's restructuring legislation gave Diablo Canyon and Palo Verde six years, ending in 2001. Northern States Power, a utility in the Great Lakes region, suggests three years of guaranteed purchases.[23]

- *How are prices set?* If the utility can earn a profit, how prices are set is both critical and contentious, with potentially significant differences between utilities and other parties.[24] Prices that are too high increase both stranded costs and utility profits at the same time.

Prices that are too low may reduce utility profits or even cause the plant to close if it cannot achieve them. Regulators must develop base prices from one or more years of historical data, as well as an escalation rate and productivity level. It also may be in the public interest to exclude some environmental and safety costs from profit-based incentive ratemaking.[25]

Another related issue is treatment of fuel and other inventories. Utilities have requested stranded cost recovery of these costs. Consumers have claimed that this allows the utility to recover the same costs twice, because they end up with free fuel and supplies to use in competitive operations.

Can Nuclear Plants Be Divested in Restructuring?

Rationale for divestiture

Proponents of divestiture suggest that divestiture of generation—including nuclear generation, if possible—is important to reduce wholesale and retail market power and avoid cross-subsidy.

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In addition, if companies begin to specialize in nuclear generation, selling nuclear plants to specialists (rather than just contracting out operations) may increase their market value and reduce the amount of stranded costs.

Rationale against divestiture

Opponents of divestiture in general believe that functionally separating generation from other services within a single utility company is adequate because market power and cross subsidies are not serious problems.

One specific argument against divesting nuclear plants is that nuclear power may have very little market value. In Britain, privatization of nuclear power was deferred for nearly 10 years after the rest of the utility industry. The market value of eight multi-unit nuclear stations was 20 percent below the construction cost of the last station. The stock price of the privatized nuclear company fell 10 percent to 15 percent on its first two days of trading.[26] In addition, required financial qualifications of new owners are strenuous. This limits the potential pool of power plant buyers.

Nuclear divestiture also may interfere with the orderly divestiture of nonnuclear generating facilities. Including nuclear with other generation in the same portfolio may limit the market of interested purchasers to those willing to accept the higher level of risk and uncertainty associated with nuclear power, thereby reducing the value of the portfolio.

Policy options

If divestiture is pursued, it will require an auction or negotiated sale to meet financial qualifications and avoid negative valuation of plants.[27] In any auction or negotiated sale, regula-

tors need to be actively involved to ensure that the process is designed to produce fair prices. However, regulatory involvement may raise concerns among potential buyers.

If nuclear generation is not divested, it still can be moved from traditional price regulation to market pricing or to a stringent performance-based ratemaking (PBR) policy to align future decisions with market economics. Such regulatory reform can ensure that ratepayers do not bear the risk for future spending on capital additions.

Waste Disposal Issues

The current state regulatory perspective is that the lack of an effective nuclear waste disposal system is a failure by the federal government to meet its responsibility.

The current state regulatory perspective is that the lack of an effective nuclear waste disposal system is a failure by the federal government to meet its responsibility. This perspective was shared by most of the January 1997 NARUC conference speakers, regardless of whether they were more or less optimistic about the desirability of and future prospects for nuclear power.[28] Under this perspective, the federal government should take charge of nuclear waste because it has been collecting money for that purpose.

The fuel disposal issue, although a federal responsibility, is important to the future of the nuclear industry because it is linked to overall plant economics, and possibly to decisions about license extension for plants that perform well.

An alternative perspective is that it is difficult and costly to deal with material that is toxic on a geologic time scale. Adherents of this view believe that fuel disposal is a part of the nuclear fuel cycle that is simply much more expensive than originally expected, and economic efficiency requires that its full cost be reflected in the competitive market.

Possible policy outcomes

The following are three possible scenarios and policy outcomes in the area of nuclear waste disposal.

- The federal government actually takes over waste disposal soon, starting with temporary facilities and moving toward a permanent disposal site. If it does this, it can subsidize the nuclear industry by leaving the disposal fee at current levels, even if it does not cover cost. Alternatively, it can raise the fee if needed to cover short-term costs and find a long-term solution. Fee increases are already being resisted by the nuclear industry.[29]

- The federal government continues to resist taking charge of nuclear waste disposal, in which case, the states and the nuclear industry take collective action against the federal government to force it eventually to take control of nuclear waste. This action has started with a recent lawsuit by several states that has established some federal responsibility.[30] It may or may not ultimately be successful.

- In either event, states will continue to muddle along for technical and political reasons until or unless the federal government develops an effective nuclear waste disposal system.

Conclusion

The nuclear industry is facing new competitive realities. Costs are declining and performance is improving for many nuclear units but, even with these improvements, costs are still high relative to market prices for a considerable number of nuclear plants, and future major capital additions will be uneconomic in many cases.

The stranded cost debate is unlikely to affect whether nuclear units continue to operate. Rather, the financial health of plant owners and the burden placed on their ratepayers is affected by the treatment of stranded capital costs. However, the decision to continue to operate nuclear plants will be based on the level of their future costs, not on past sunk costs. If future costs are low, they will operate; if not, they will close. Recovery of past sunk costs has little effect on this outcome.

The stranded cost debate is unlikely to affect whether nuclear units continue to operate.

The main question for state regulators and legislators is whether nuclear generation should undergo transition toward competition through a guaranteed market, or whether to require nuclear power to compete immediately based on its incremental costs. State regulators must also decide whether to ensure that decommissioning and other safety-related costs such as O&M costs for shutdown plants are collected. The federal responsibility for overall safety regulation and the difficult question of fuel disposal will affect how many units continue to operate for how long. States can influence the fuel disposal issue only indirectly.

Notes

1. Each year, *Nuclear News* publishes an article evaluating the average capacity factor for nuclear plants over the previous three years. The reported data are complied from this source.

2. Plants on the NRC Watch List typically had lower than average O&M costs before being listed but incurred $123 million to $233 million in excess costs after being listed. "Study Says Watch List Hikes O&M $147 Million on Average," *Nucleonics Week*, May 29, 1997, pp. 10-11.

3. NARUC Conference, January 23, 1997, Steven Specker, General Electric, transcript p. 93. Dr. Specker observes that virtually all could compete with 20 percent lower O&M, 30-day refueling outages (compared to a 50 to 60 day average now) and a 5 percent increase in power output.

4. For example, California utilities project power exchange (PX) prices of 2.3 cents to 2.5 cents per kWh.

5. W. B. Marcus, *Analysis of the Performance of Nuclear and Supercritical Coal Plants for Maryland's Generation Unit Performance Program*. Report for the Maryland Office of People's Counsel, March 1996.

6. This finding from JBS' data base is also confirmed by James Asselstine of Lehman Brothers (NARUC Conference, January 24, 1997, pp. 150-151).

7. General Public Utilities, "GPU Filing to Propose Future Options for Oyster Creek Nuclear Generating Station," April 10, 1997, press release, downloaded from Internet.

8. Commonwealth Edison, "ComEd Foregoes Steam Generator Replacement for its Zion Station," April 17, 1997, press release, downloaded from Internet.

9. Sheldon D. Strauss, "Honing the Competitive Edge at Nuclear Powerplants," *Power*, June, 1996, pp. 33-43. These views also were expressed at the Jan. 23, 1997, NARUC Conference by several speakers.

10. The extended closure at Millstone was exacerbated when it was found that the operator violated NRC rules and short-cut procedures to reduce refueling time. See also DeAnn Weimer, "FPL Workers Facing Dark Days at the Light Company,: *Palm Beach Post*, Oct. 15, 1995, from Internet; and Shirley Jackson, chair of the NRC, who stated that Maine Yankee's problems result from both cost-cutting and corporate culture. NARUC Conference, Jan. 23, 1997, p. 176.

11. A good example is Salem. "Idled Salem Capital, O&M Costs Near $1 Billion over Two Years," *Nucleonics Week*, March 13, 1997, p. 1. This amount does not cover new steam generators.

12. NARUC Conference, January 23, 1997, David Clark, Uranium Exchange Co., p. 265ff.

13. R. G. Schoenberger and R. L. Cudlin, "Capturing Stranded Value in Nuclear Plant Assets," *Electricity Journal* 9, June 1996, pp. 59-65.

14. NARUC Conference, January 23, 1997, Peter Bradford, Regulatory Assistance Project, pp. 144-5.

15. "RG&E and Niagara Mohawk Plan to Form Joint Operating Company," *Nucleonics Week*, October 17, 1996, pp. 1-2.

16. Ibid., January 23, 1997, James J. Howard, Northern States Power, pp. 72, 76, 103.

17. To provide one example, these costs could be as much as $6.5 billion in capital costs plus return and taxes for Pacific Gas and Electric Company's Diablo Canyon units.

18. The term "shutdown O&M costs" refers to O&M costs after plant closure. These O&M costs are necessary to close the plant, move it to an inactive state, and provide ongoing security and monitoring until decommissioning occurs. Shutdown O&M costs are estimated in the California nuclear settlements as 80 percent of the average O&M costs of an operational plant in the first year, 50 percent of O&M costs in the second year and 10 percent of average O&M costs in subsequent years.

19. NARUC Conference, January 23, 1997, Shirley Jackson, NRC chair, p. 186.

20. W. B. Marcus, *Analysis of Pacific Gas & Electric Company's Proposed Modification of Pricing for the Diablo Canyon Nuclear Plant*, CPUC App. 96-03-054, September 1996, pp. 2-3.

21. See, for example, Daniel W. Fessler "California's Move from Integrated Monopolies to Competitive Generation: Smooth Transition, Not Shock Therapy," *Nuclear News*, May 1996, pp. 36-39.

22. Ibid., see also NARUC Conference, January 23, 1997, Gregory Conlon, California PUC, p. 273.

23. NARUC Conference, January 23, 1997, Steven Specker, General Electric, pp. 105-107.

24. In California, for example, differences between utilities and intervenors in 1996 on prices from 1997-2001 were 28 percent for Palo Verde and 19 percent—or $455 million—for Diablo Canyon.

25. The following case history shows why regulators might consider excluding these costs from incentive ratemaking. The California PUC adopted fixed prices for San Onofre that included costs of environmental mitigation previously ordered by the California Coastal Commission (CCC). SCE then asked the CCC to relax its requirements and reduce mitigation costs. Under SCE's proposal, all the cost savings would have increased utility profits. Ratepayers would have paid for environmental mitigation that never was performed. The CCC finally rejected SCE's proposal only after more than 18 months of controversy and three hearings.

26. "Investors Suffer Losses as Shares in British Energy Open for Trading," *Nucleonics Week* 37, No. 29, July 18, 1996, p. 6.

27. Stock spin-offs or sale of generation corporations may run afoul of the financial requirements or value nuclear units at less than zero, offsetting positive values of other generation assets.

28. NARUC Conference, Jan. 23, 1997, Paul Evanson, p. 19; John Hanger, Pennsylvania PUC, p. 30; James J. Howard, pp. 72, 103; Krista Sanda, Minnesota PSC, Nuclear Waste Strategy Coalition, pp. 326-352.

29. NARUC Conference, Jan. 23, 1997, Krista Sanda, p. 352.

30. Florida Public Service Commission, "Court Moves Forward on Nuclear Waste Disposal Lawsuit." News release, May 1, 1998, downloaded from Internet.

Resources

The August/September 1997 *Electricity Journal* contains five articles on nuclear power in a restructured environment. As a whole, they make a significant contribution to understanding the relationship of nuclear power to restructuring, although they contain less information about the expected future of the nuclear industry or individual plants. Each individual article is discussed below in order of appearance in the *Journal*.

Edward P. Kahn, "Can Nuclear Power Become an Ordinary Commercial Asset," *Electricity Journal*, August/September 1997, pp. 16-21.
This article identifies features that distinguish nuclear power from other generating facilities as the greater safety concerns and waste disposal and decommissioning issues. The article suggests that efficiencies may be gained by selling nuclear plants to entities that are most qualified to operate them, that market power issues remain important if nuclear ownership becomes concentrated, and that units most likely to be saleable are not the oldest units.

Kenneth C. Rogers, "NRC's Concerns About Electric Restructuring," *Electricity Journal*, August/September 1997, pp. 22-26.
The author, an NRC commissioner, believes that nuclear power can survive and prosper under restructuring, but that changes may be needed. In particular, it is likely to be necessary to strengthen the financial assurance requirements for nuclear decommissioning and safety funding. The NRC is concerned about the potential for increasing grid-related outages at nuclear plants if transmission and generation are organizationally separated. The author believes that it will be necessary to continue open sharing of information about safety-related issues despite concerns regarding competition. A shift in the NRC's regulatory stance toward "risk-informed performance-based regulation" is seen as a way to reduce utility costs to achieve the same level or greater safety protection than current regulation. Finally, the need to act more quickly to deal with problem plants was identified as a means of assuring public trust.

David A. Perlman, "Selling a Nuclear Plant in North America," *Electricity Journal*, August/September 1997, pp. 27-31.
The author states that many conventional commercial considerations (risk profiles, diversification over a number of units, economic life, discounted cash flow considerations) will affect the saleability and price of nuclear plants. Political and regulatory considerations and the uncertainties of the restructuring process itself may make sales more difficult. Seven difficult questions for due diligence review of a nuclear sale are identified.

- Marvin Raber and Robert W. Hasell, "Nuclear Power in the Competitive Marketplace: Price Expectations and Going Forward Costs," *Electricity Journal*, August/September 1997, pp. 32-40.
  The article models future energy prices on a regional basis and compares them to nuclear costs. The article does not review individual plants but, instead, examines scenarios. Two nuclear scenarios are modeled. The optimistic case assumes an 85 percent capacity factor, flat nominal dollar fuel costs, a decline in real dollars of 40 percent in nuclear O&M costs, and a significant reduction in capital additions costs. Under this scenario, nuclear profits are extremely high. Profits are more limited (and negative in some regions) with the more pessimistic scenario (70 percent capacity factor, a 22 percent real decline in O&M costs by 2000, flat real dollar fuel costs and capital additions based on current trends).

- Geoffrey S. Rothwell, "Continued Operation or Closure: The Net Present Value of Nuclear Power Plants, *Electricity Journal*, August/September 1997, pp. 41-48.
  The paper offers a methodology to compare nuclear plant costs to determine whether a plant should remain open or be closed. Case studies of Trojan and Yankee Rowe are presented. The sensitivity of the present value of costs or benefits of continued nuclear plant operation to price and real fuel escalation rates is shown.

- U.S. Office of Technology Assessment, *Aging Nuclear Power Plants: Managing Plant Life and Decommissioning*, Washington, D.C.: U.S. Government Printing Office, September 1993.
  While the reference is several years old, the report comprehensively addresses economic and safety concerns regarding aging nuclear plants. It suggests that reactor operators must manage "aging degradation" to promote safe and economic operation of nuclear units but identifies no specific conditions that will cause reductions in safety. Case studies of economic and safety-related issues affecting nine different units are presented. The report also reviews decommissioning cost estimates.

- R. G. Schoenberger and R. L. Cudlin, "Capturing Stranded Value in Nuclear Plant Assets," *Electricity Journal* 9, June 1996, pp. 59-65.
  This paper discusses the New York Power Authority's analysis of contracting out operation of nuclear units. It develops the theory that a two-tier nuclear industry is developing, with several companies, termed "advanced nuclear enterprises" achieving nearly uniform success. The authors see much more variable performance among the remainder of the industry. A key to success for some smaller nuclear plant operators is contracting out operations to an advanced nuclear enterprise.

W. B. Marcus, *Analysis of the Performance of Nuclear and Supercritical Coal Plants for Maryland's Generation Unit Performance Program*. Report prepared for the Maryland Office of People's Counsel, West Sacramento, Calif.: JBS Energy Inc., March 1996.
This report was prepared to analyze nuclear capacity factors for the Maryland Generation Unit Performance Program (GUPP) using regression analysis. The report uses regression analysis to document the overall improvement in industry performance in recent years, as well as one-time factors and complex interactions between size, reactor manufacturer and plant age that affect expected performance of individual units.

J. S. Rohrbach, "U.S. Nuclear Decommissioning Trust Planning: Romancing a Millstone?" *Electricity Journal* 9, June 1995, pp. 56-61.
The experience of decommissioning Trojan and Yankee Rowe may indicate that nuclear decommissioning is more expensive than originally planned and that many utilities may have very large unfunded decommissioning liabilities. The report recommends that state regulators generally adopt more conservative assumptions regarding nuclear decommissioning costs to assure adequate cost recovery in decommissioning trust funds.

U. S. General Accounting Office. "Nuclear Regulation: Preventing Problem Plants Requires More Effective NRC Action. Washington, D.C.: U.S. General Accounting Office report, GAO/RCED-97-145, May 1997.
This report analyzes the NRC's actions to prevent safety-related problems using case studies of the Salem, Millstone and Cooper nuclear plants. The report outlines how the NRC currently oversees existing plants with resident inspectors and how it steps up monitoring activities at plants on the NRC Watch List. It concludes that, overall, industry safety performance is good and improving, but that the number of problem plants is increasing. The report identifies NRC actions that allowed safety problems to persist and worsen at several plants. It recognizes that the NRC's performance is improving, but there is a need to change the "culture of tolerating plant problems." The report contains detailed appendices about the NRC's regulatory framework and each of the three plants for which case studies were conducted.

R. C. Callen, "Nuclear Waste: Contract with America" *Electricity Journal* 9, June 1995, pp. 45-55.
The article discusses the need for nuclear waste disposal and suggests organizational changes to improve accountability in federal waste disposal.

- C. Komanoff and C. Roelofs, "Predicting Nuclear Plant Capacity Factors," *Public Utilities Fortnightly*, Dec. 1, 1994.
  This article outlines a number of one-time and ongoing factors that affect nuclear capacity factors, including plant size, construction timing, aging, salt water cooling, appearance on the Nuclear Regulatory Commission's Watch List, etc.

- In addition to the above articles, the trade publications *Nuclear News* (monthly) and *Nucleonics Week* contain valuable current information, although often presented from a nuclear industry standpoint. Both these publications contain ongoing reports about nuclear power plant production and capacity factors (a report on the most recent three-year average in May or June of each year for *Nuclear News* and data published on a monthly basis in *Nucleonics Week*). *Nucleonics Week* also publishes a compendium of operations and maintenance costs for U.S. plants in the spring of each year.

- Finally, the web site of the Nuclear Regulatory Commission (located at http://www.nrc.gov/) contains systematic evaluation of licensee performance (SALP) reports issued by the NRC regarding the safety performance of each nuclear plant in the United States. In addition, documents filed in NRC proceedings, including the docket relating to electric industry restructuring, can be found through the NRC web site, although it is quite cumbersome to search for documents filed in NRC dockets that currently are not in progress.

People

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The Institute for Resource and Security Studies (IRSS) is an independent, nonprofit, tax-exempt corporation founded in 1984 to promote efficient use of natural resources, peace and international security, and protection of the environment. IRSS has analyzed nuclear power and nuclear weapons issues for several years for a variety of clients. Its reports range from detailed technical studies to educational materials for the general public. To complement its analytic and educational work, IRSS also engages in public participation, dialogue facilitation and conflict management through its Program on Promoting Understanding and Cooperation. IRSS also manages the Electricity Information Project, a cooperative project to provide information to inform decisionmakers about issues related to the restructuring of the U.S. electricity industry.

Charles Komanoff, Komanoff Energy Associates, New York, N.Y.
Charles Komanoff has analyzed nuclear plant costs and performance for more than 20 years. He has conducted detailed regression analyses of plant costs and capacity factors for many clients in Canada and the United States and has written several articles about the relative economics of nuclear and coal power.

Tim Martin, Tim D. Martin and Associates, Herndon, Va.
Mr. Martin and his firm have experience in benchmarking, best practices analysis, hands-on work assisting with staffing and materials management at nuclear and other utility power plants, and strategic planning. He is the author of a recent study showing that firms that end up on the NRC's Watch List have lower than average costs before being listed but spend an extra $142 million to $319 million on O&M and capital costs after listing. Mr. Martin's client base consists mainly of utilities, but he has expressed interest in being a conference speaker or panelist to assist state governments.

Bruce Biewald, Synapse Energy Economics Inc., Cambridge, Mass.
Mr. Biewald has analyzed nuclear issues for several years. He has particular expertise in the analysis of nuclear decommissioning cost estimates and policy options, including a 20-year review of decommissioning cost trends by industry experts. He also has analyzed operating costs, capacity factors and capital spending for nuclear units. Mr. Biewald also has testified on other restructuring issues such as market power and stranded costs.

- **William B. Marcus**, JBS Energy Inc., West Sacramento, Calif.
  Mr. Marcus has analyzed nuclear capacity factor and cost issues for several clients in the United States and Canada. He and JBS have projected future performance of nuclear plants, developed cost benchmarks for nuclear plants, analyzed the cost-effectiveness of decisions to invest money in nuclear capital additions, and analyzed the effect of varying nuclear performance assumptions on utility system costs. Mr. Marcus also has been involved in developing stranded cost estimates for the California utilities, evaluating California's nuclear industry.